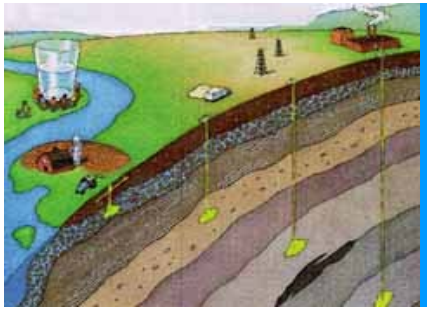
Geologic Sequestration of Carbon Dioxide
EPA Proposed Rulemaking

6th Annual EOR Carbon Management Workshop – Houston, TX

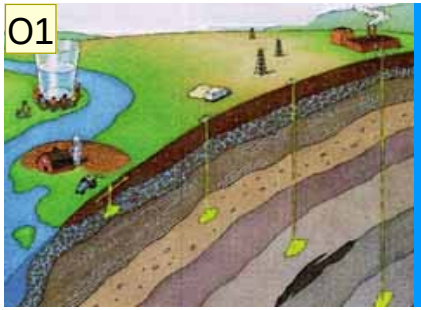
U.S. Environmental Protection Agency
Office of Ground Water and Drinking Water
December 8, 2008



EPA's Proposed GS Rule: *Outline*

- Brief UIC Background
- Proposal Development Process
- Components of the Proposed Rule
- Schedule for Final Rule
- Public Hearing Results

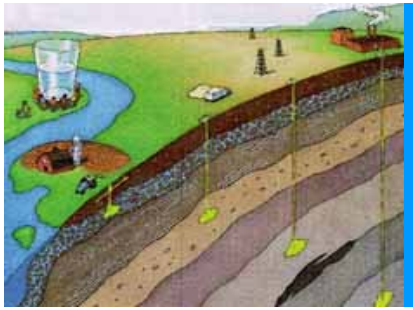
O1



UIC Background – Safe Drinking Water Act Authority

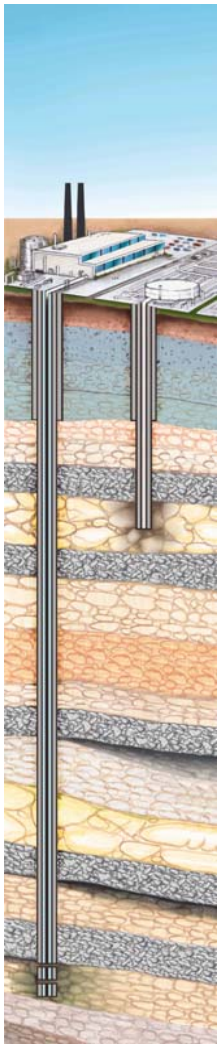
- The 1974 SDWA (Reauthorized in 1996)
  - Minimum federal regulations for protection of Underground Sources of Drinking Water (USDWs)
  - USDW defined:
    - Any aquifer or portion of an aquifer that contains water that is less than 10,000 PPM total dissolved solids or contains a volume of water such that it is a present, or viable future, source for a Public Water Supply System
- UIC Program regulates underground injection of *all* fluids – liquid, gas, or slurry
  - Designation as a commodity does not change SDWA applicability
  - Some natural gas (hydrocarbon) storage, oil & gas production, and some hydraulic fracturing fluids exempted
- Existing UIC program provides a regulatory framework (baseline) for the Geologic Sequestration of CO_2

O1 OGC, 9/16/2008

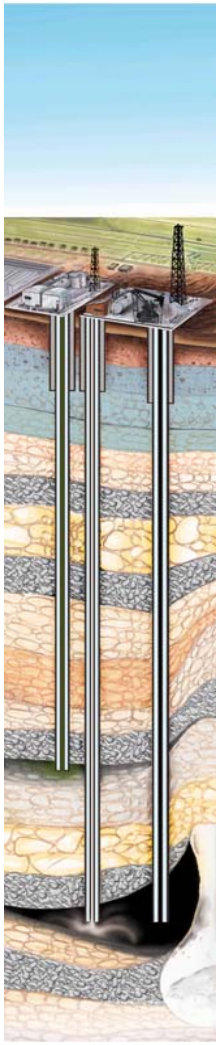


UIC Background: *UIC Well Classes*

Class I

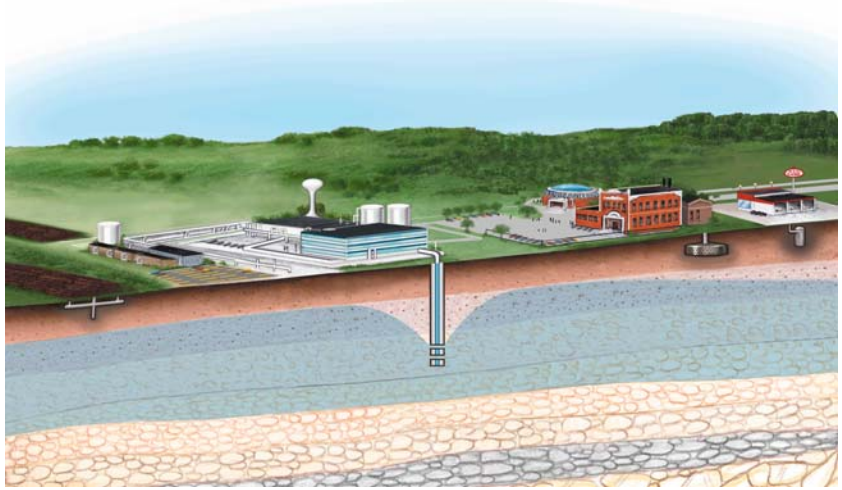


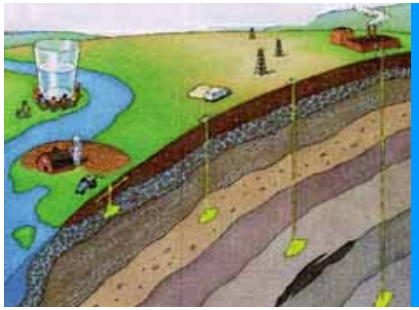
Class II



Class III

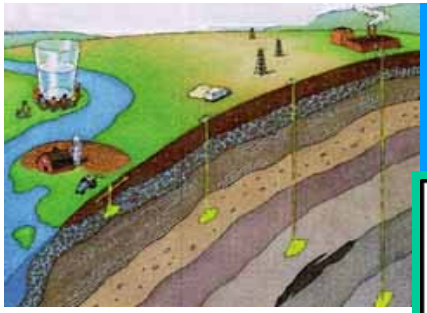
Class V





Carbon Capture and Storage/Geologic Sequestration of CO_2

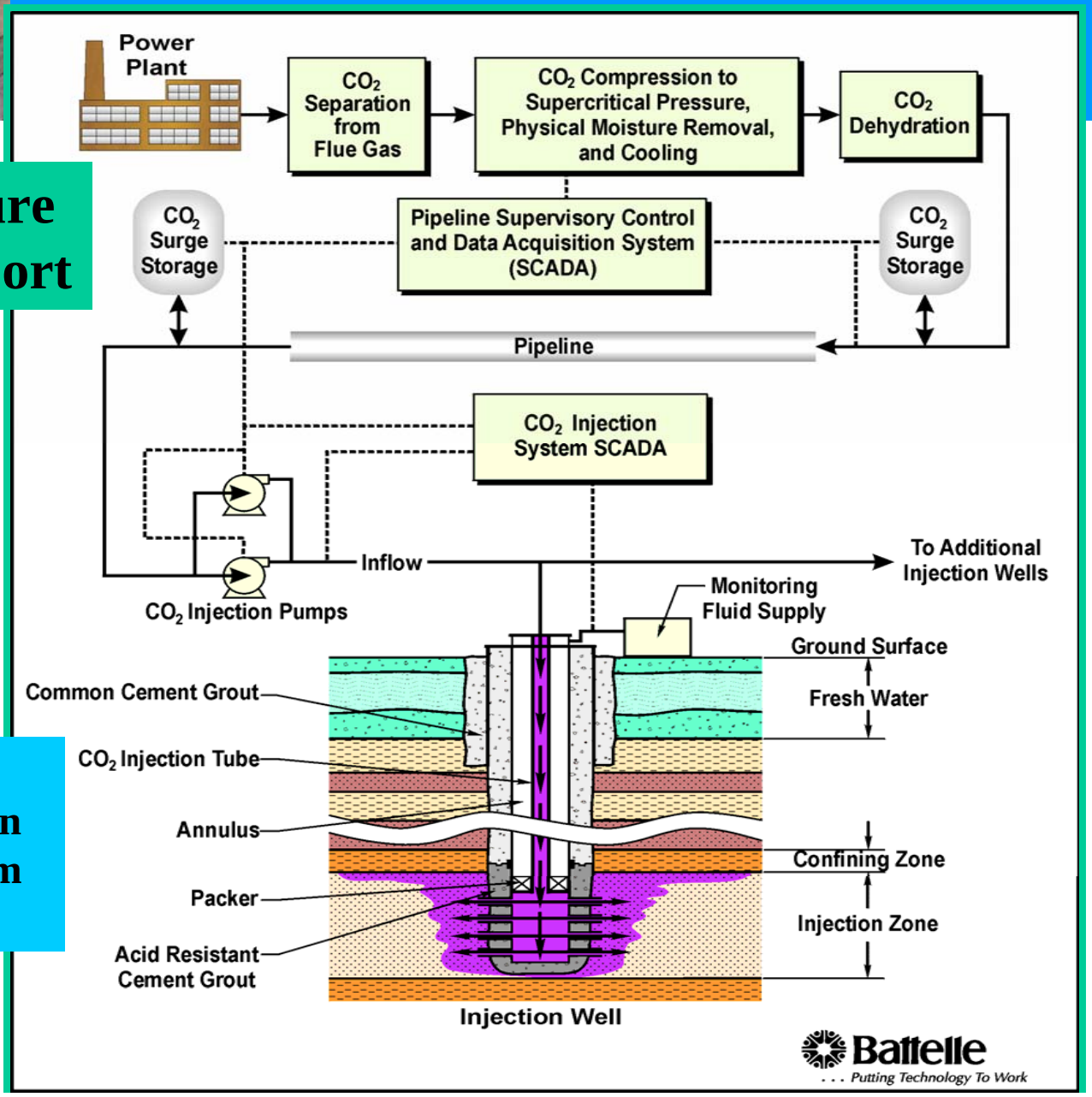
- Important terms:
  - CCS: ***Carbon Capture and Storage*** (includes capture, transport, and injection of carbon dioxide for long term storage)
  - GS: ***Geologic Sequestration*** (the injection of carbon dioxide for long term storage)
- GS is but one tool that can be used to reduce emissions of carbon dioxide to the atmosphere (there are others)
- CCS is key to meeting the Administration's climate goals
- GS rule addresses potential endangerment to underground sources of drinking water from CO_2 injection activities
  - provides consistency across US
  - provides transparency that will build public confidence

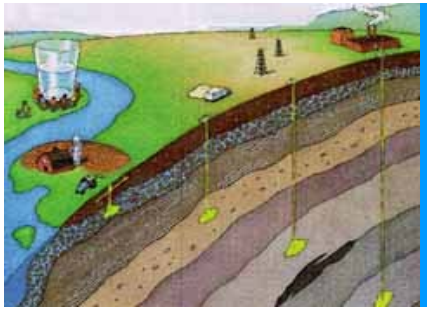


CO_2 Capture and Storage

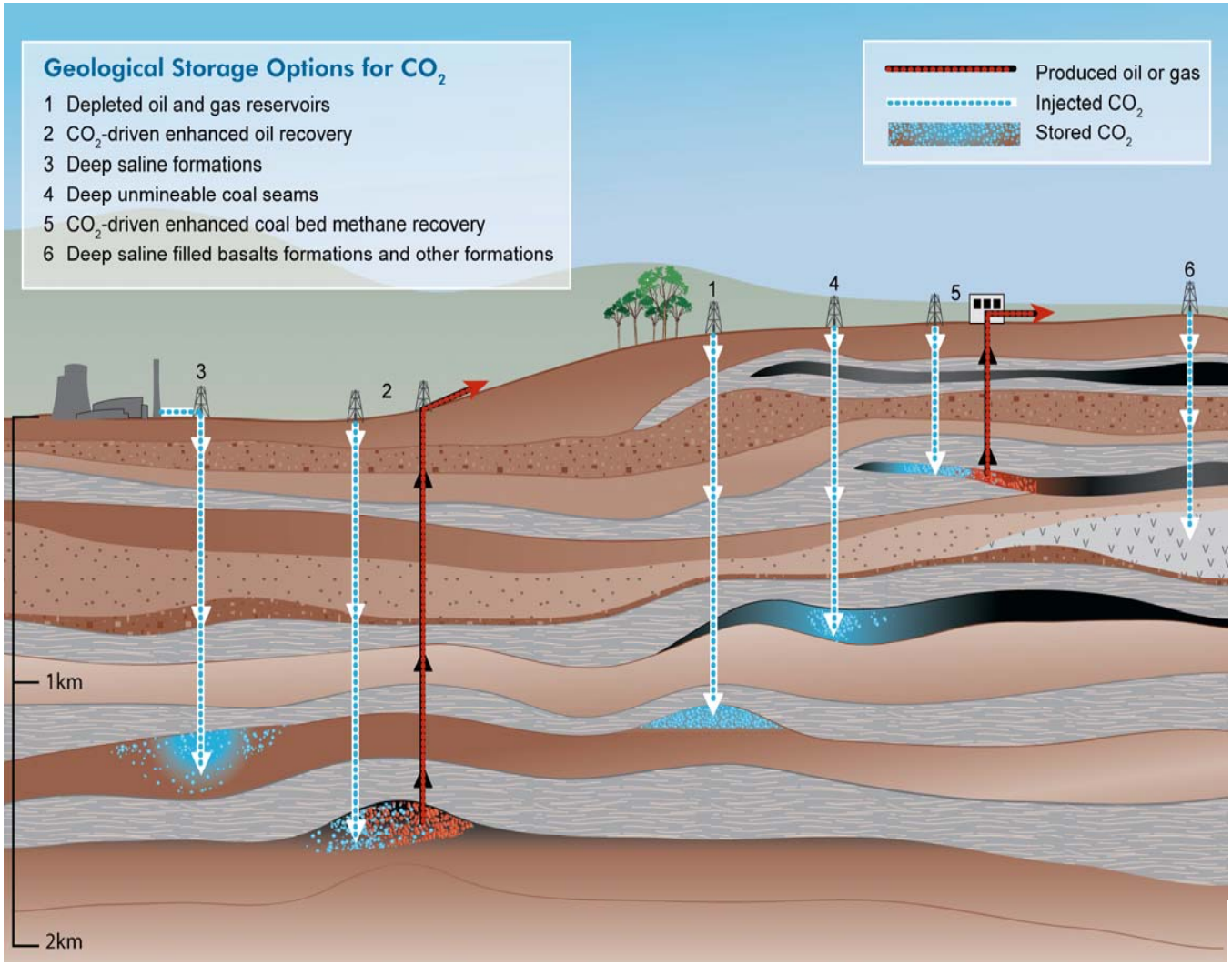
CO_2 Capture and Transport

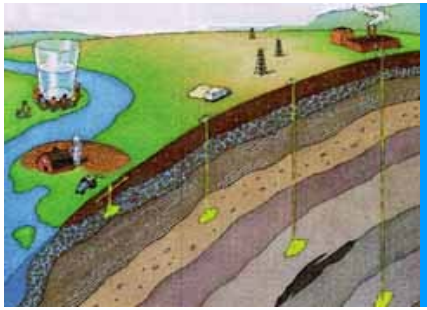
Geologic Sequestration UIC Program Scope





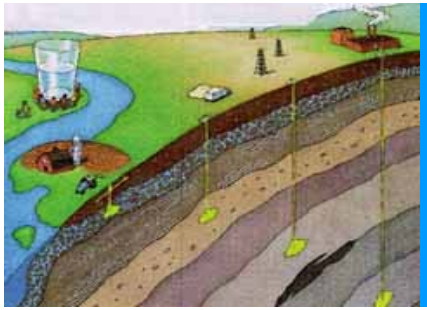
GS Target Formations





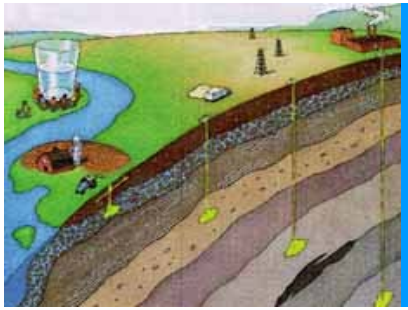
EPA's Proposed GS Rule: *Rule Development Process*

- EPA has developed a **Proposed Rule** for Geologic Sequestration (GS) of CO_2
  - Announced October 11, 2007
  - Signed July 15, 2008, Published July 25, 2008
  - Public Hearings held September 30th and October 2nd
  - 120-day comment period + 30 day comment extension
- Proposed rule uses Safe Drinking Water Act (SDWA) authorities and revises Underground Injection Control (UIC) Program for GS (Class VI)
- Priority placed on avoiding endangerment of underground sources of drinking water



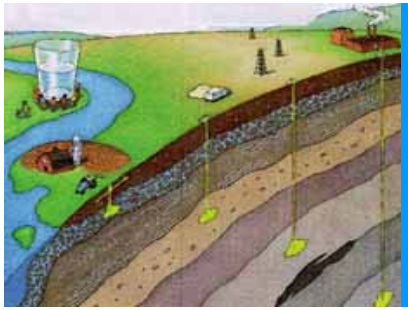
EPA's Proposed GS Rule: *Collaboration*

- EPA's Offices of Water and Air and Radiation worked to:
  - Clarify and address issues across EPA statutes (SDWA, CAA, etc.) and regulations
  - Coordinate technical and cost analyses for the proposal
- Workgroup of ~48 members included DOE and 4 States (Texas, Arkansas, Alabama and Ohio)
- EPA works closely with the Department of Energy (Lead)
- EPA coordinating with:
  - Department of Transportation
  - Bureau of Land Management
  - United States Geological Survey



EPA's Proposed GS Rule: *Outreach to Stakeholders*

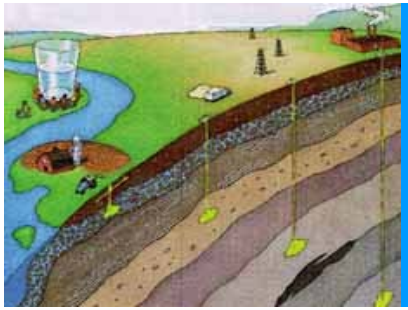
- **Federal Advisory Committees –** National Drinking Water Advisory Council (NDWAC) and Clean Air Act Advisory Committee (CAAAC)
- **States –** Ground Water Protection Council (GWPC) and Interstate Oil & Gas Compact Commission (IOGCC)
- **Non-Governmental Organizations and Water Utilities –** National Resources Defense Council, World Resources Institute, Environmental Defense, AWWA and others
- **Industry Groups –** BP, Shell, Chevron, American Petroleum Institute, Schlumberger, Edison Electric Institute, etc.



EPA's Proposed GS Rule: *Workshops and Meetings*

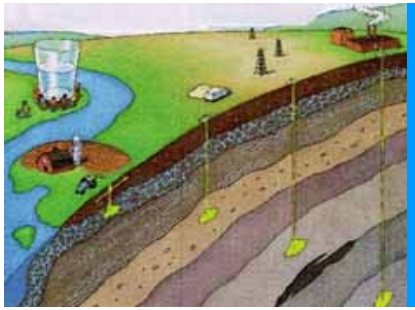
- **Technical Workshop Series (2005-2008)**
  - Modeling: Houston, TX 2005
  - Risk Assessment: Portland, OR 2005
  - Site Characterization: Berkeley, CA 2006
  - Well Construction and Mechanical Integrity Testing: Albuquerque, NM 2007
  - Area of Review: Washington, DC 2007
  - Measurement, Monitoring, and Verification: New Orleans, LA 2008

- **Two Stakeholder Meetings (2007 & 2008 in DC Area)**
  - EPA's rulemaking process
  - Technical and implementation challenges



EPA's Proposed GS Rule:
Goals of the Rulemaking Process

- Develop proposed rules that would protect underground sources of drinking water under SDWA
- Adapt existing UIC program requirements to unique needs of GS of CO_2 for long-term storage
- Develop adaptive approach to incorporate new data
- Use existing experience with industrial and enhanced oil/gas recovery injection



EPA's Proposed GS Rule: *Approach to Rulemaking*

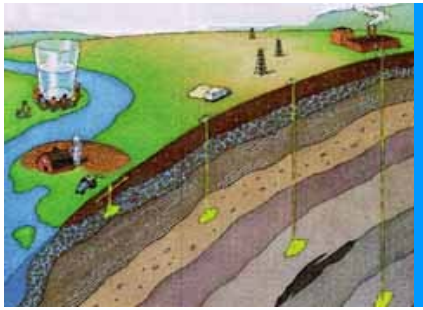
Special Considerations for GS

- Large Volumes
- Buoyancy
- Viscosity (Mobility)
- Corrosivity

UIC Program Elements

- Site Characterization
- Area Of Review
- Well Construction
- Well Operation
- Site Monitoring
- Well Plugging and Post-Injection Site Care
- Public Participation
- Financial Responsibility
- Site Closure

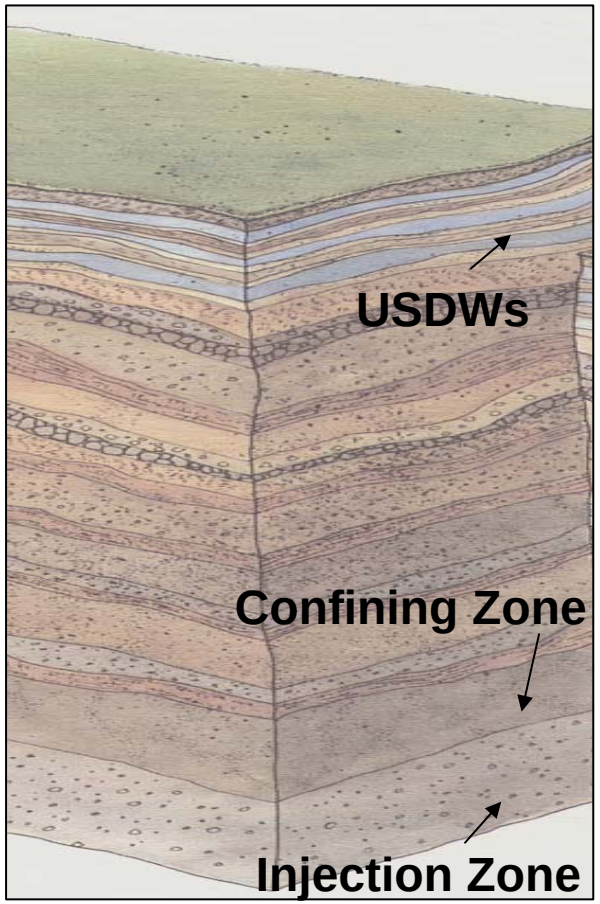
Develop new well class for GS – Class VI

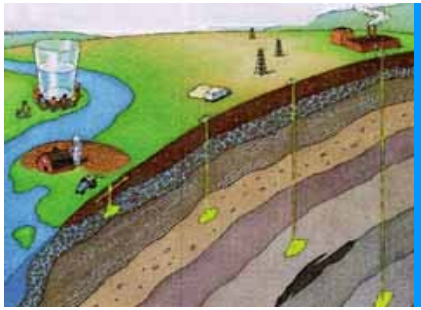


EPA's Proposed GS Rule: *Site Characterization*

Basic requirements

- Injection zone that can accept fluids
- Confining zone (system) above the injection zone, that contains all fluids

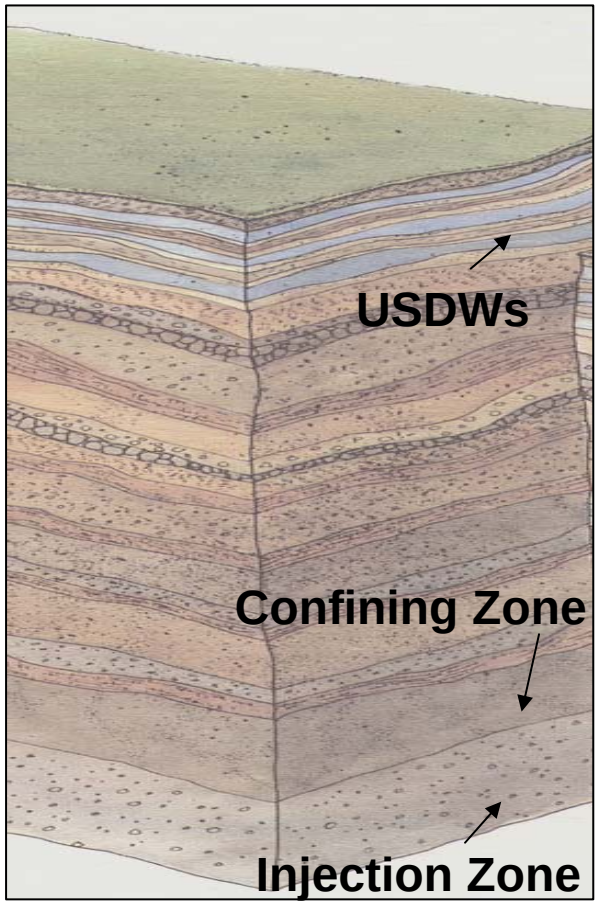


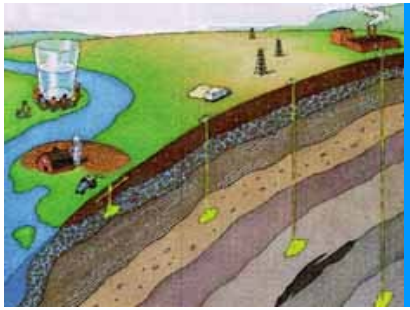


EPA's Proposed GS Rule: *Site Characterization*

Proposed Approach

- Director has discretion to require identification of additional confining zones
- Owners and Operators submit information on the following:
  - Structure and stratigraphy
  - Seismicity
  - Baseline geochemistry



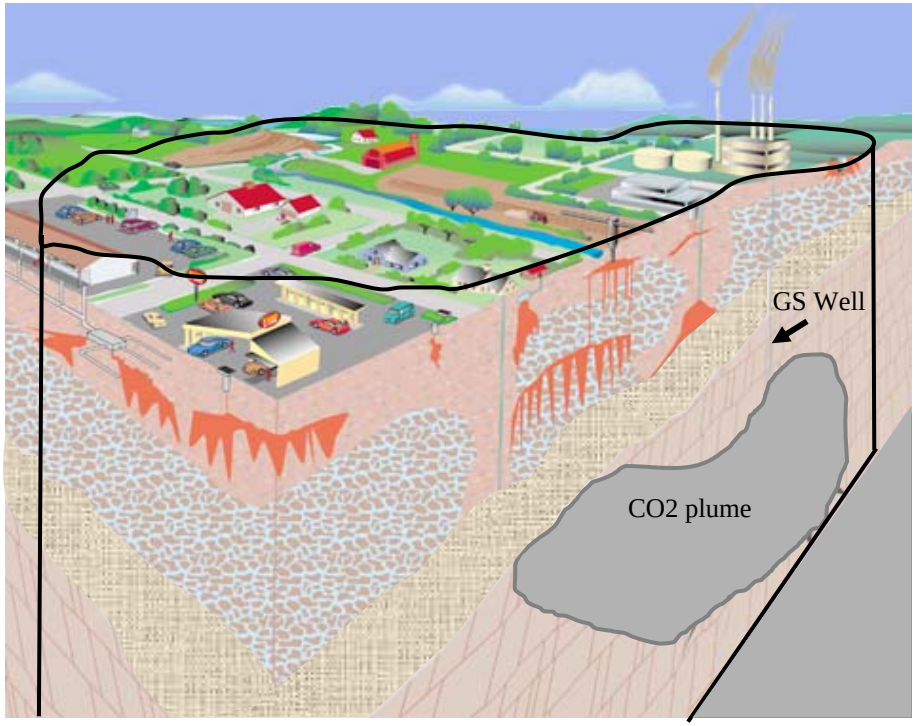


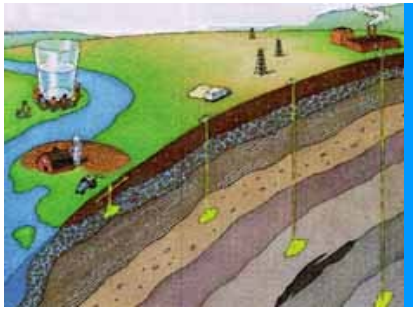
EPA's Proposed GS Rule: *Area of Review (AoR)*

AoR: The region surrounding the project that may be impacted by injection activity

Basic requirements

- Delineate the AoR
- Identify and evaluate all artificial penetrations and other features that may allow upward migration of fluids
- Plug and or remediate as appropriate

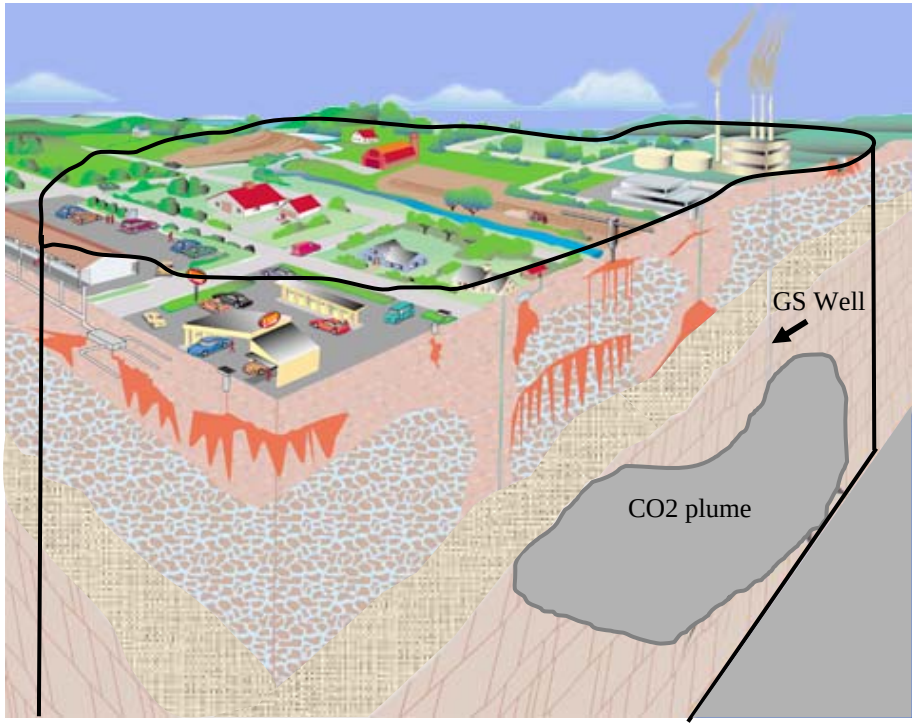


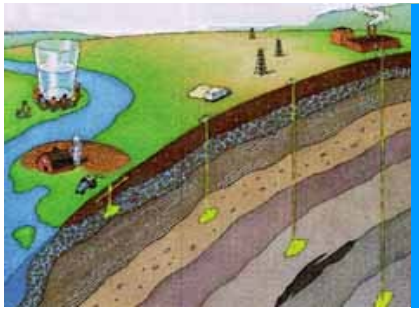


EPA's Proposed GS Rule: *Area of Review (AoR)*

Proposed Approach

- Use computational modeling
- AoR reevaluation at a minimum of every 10 years
- Use phased corrective action at Director's discretion

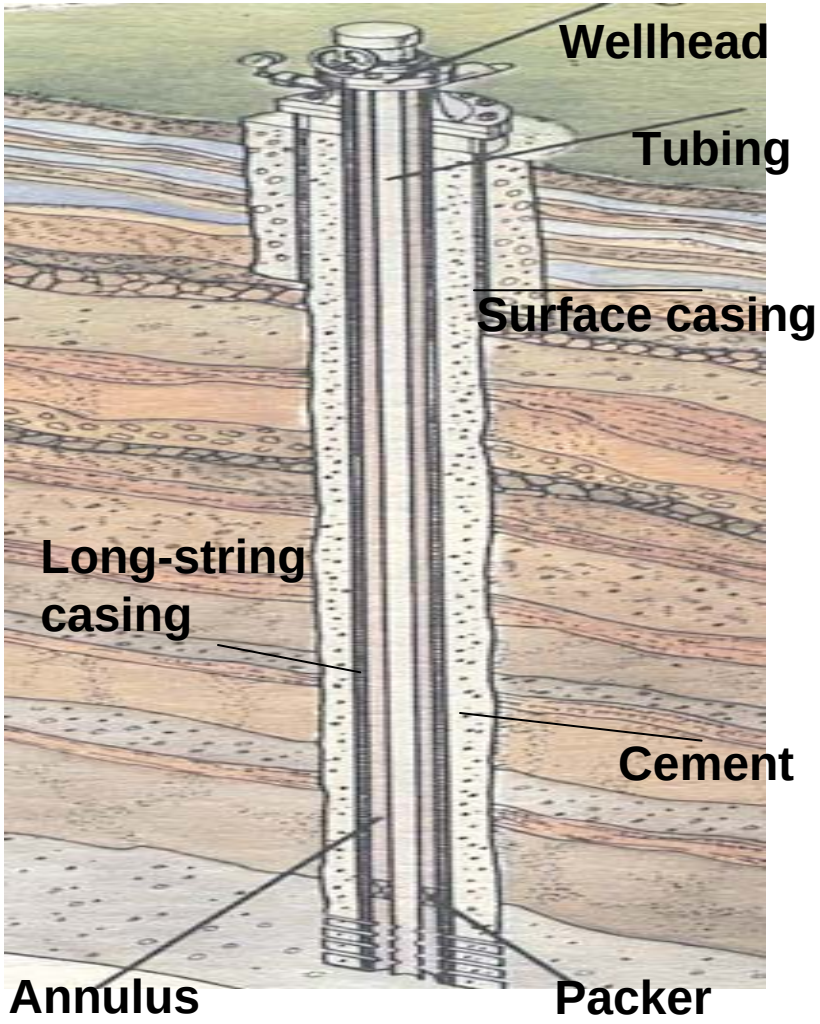


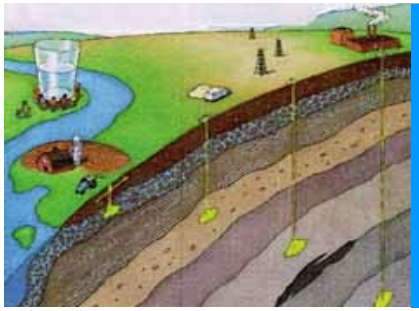


EPA's Proposed GS Rule: *Well Construction*

Basic requirements

- Well components engineered to ensure protection of USDWs
  - Cased and cemented to prevent movement of fluids into an USDW
  - Surface casing and long string casing
  - Tubing and packer

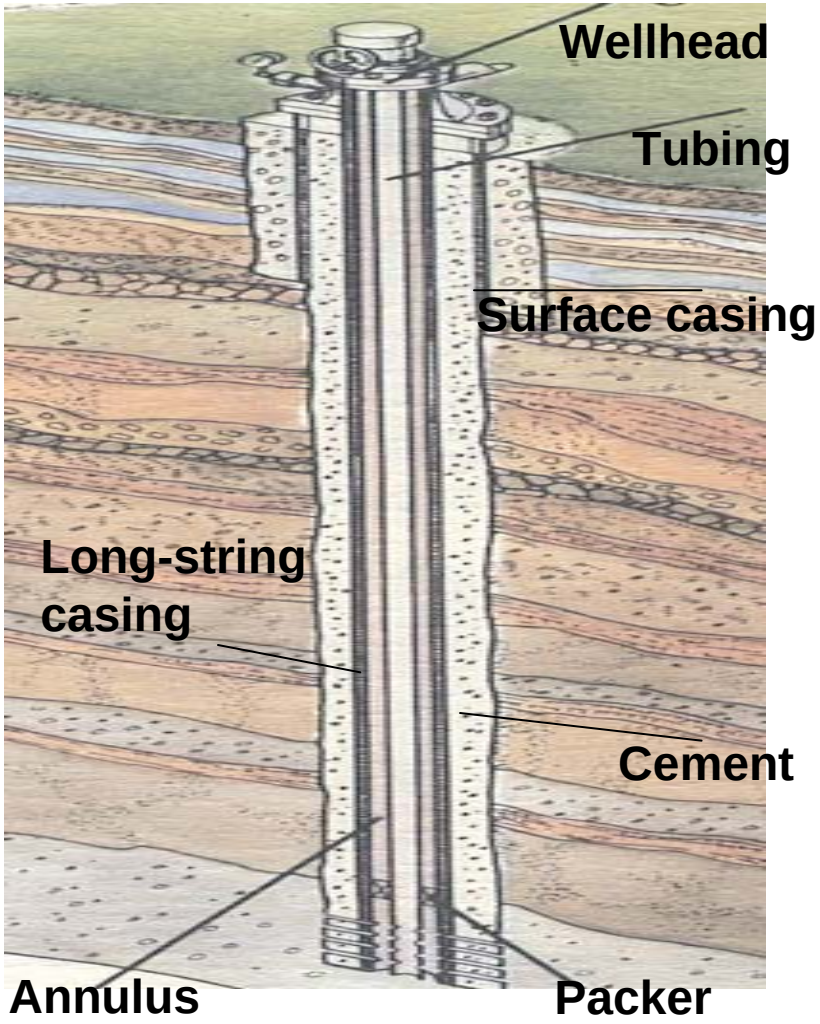


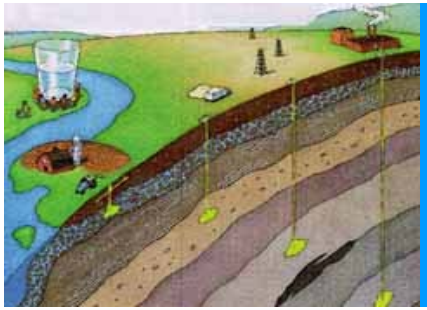


EPA's Proposed GS Rule: *Well Construction*

Proposed Approach

- Inject below the lowermost USDW
- Long-string casing cemented in place for entire length
- Surface casing through the base of the lowermost USDW and cemented to surface
- Well materials must be compatible with injectate and formation fluids

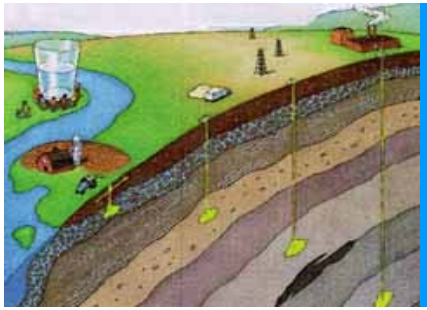




EPA's Proposed GS Rule: *Well Testing and Operation*

Basic requirements

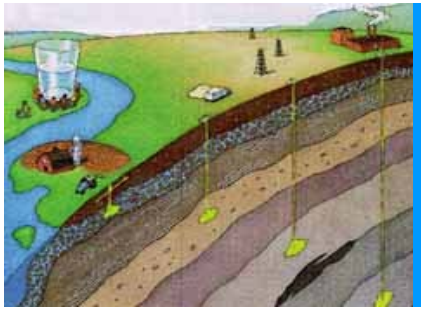
- Procedures to ensure integrity of the well before, during, and after injection
  - Injection may not fracture confining zone
  - Monitor injection pressure, flow rate and volumes, and the nature of the injected fluid
  - Perform mechanical integrity tests



EPA's Proposed GS Rule: *Well Testing and Operation*

Proposed Approach

- Continuous internal well mechanical integrity tests (MIT) and annual external MITs
- Injection pressure should not exceed 90 percent of fracture pressure of the injection zone

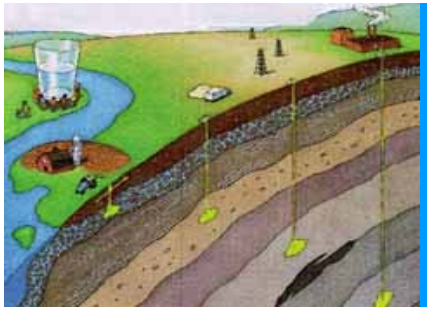


EPA's Proposed GS Rule:

Impacts on Existing UIC Wells (Class I, II, V)

Proposed Approach

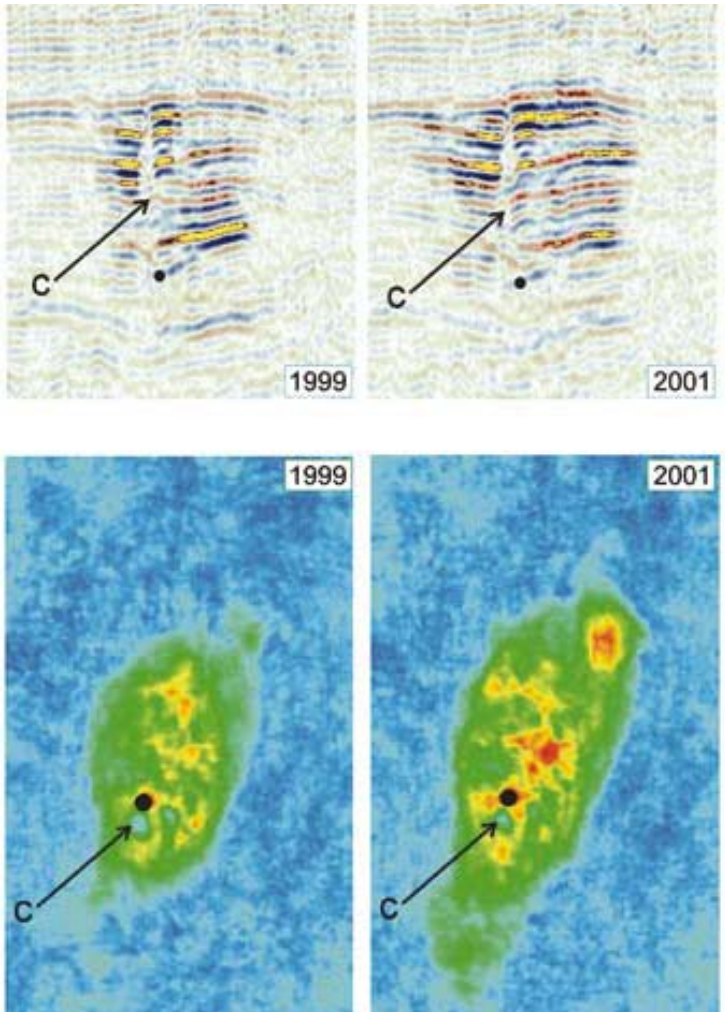
- CO_2 Enhanced Oil/Gas Recovery Wells (Class II) would not be required to apply for a Class VI permit until NO oil is being produced from the reservoir
- Existing Class I, II or V wells that transition to a Class VI permit must comply with all new regulations, except….
- "Cemented-in-place" mechanical components of the well would be grandfathered into the new permit



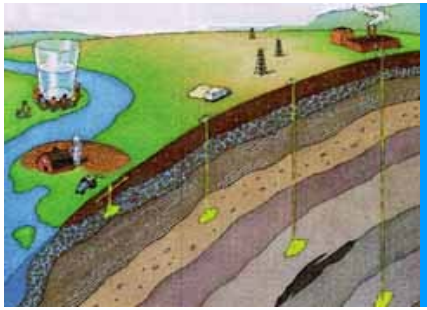
EPA's Proposed GS Rule: *Site Monitoring*

Basic requirements (for Class I Hazardous Wells)

- Director has discretion to require site specific monitoring
- If required, determine the movement of fluid and area of elevated pressure



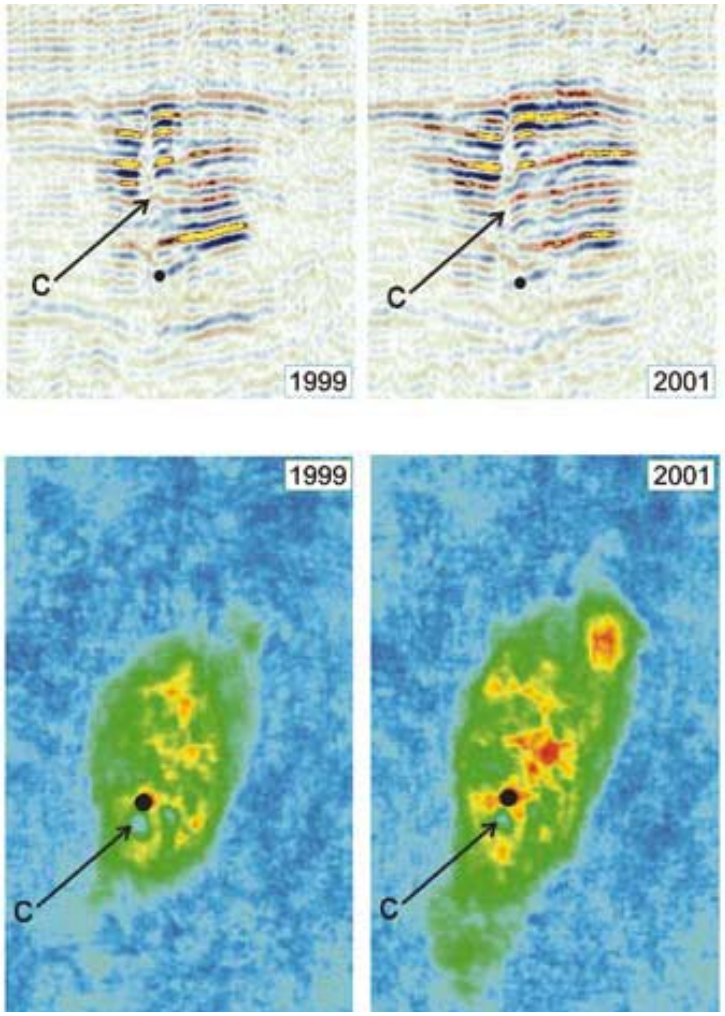
Seismic Monitoring Results, Sleipner



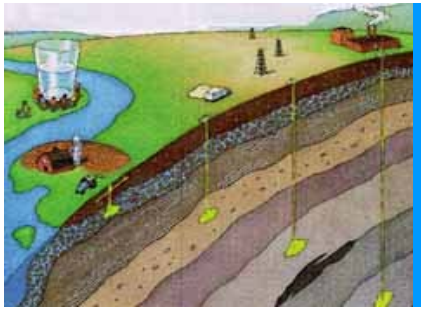
EPA's Proposed GS Rule: *Site Monitoring*

Proposed Approach

- Determine extent of CO_2 movement and associated area of pressure (pressure front)
- Tracking of the plume and pressure front is required, but techniques, frequency, and spatial resolution are not specified
- Tracers are not required
- Surface-air and soil-gas monitoring are at the Director's discretion



Seismic Monitoring Results, Sleipner

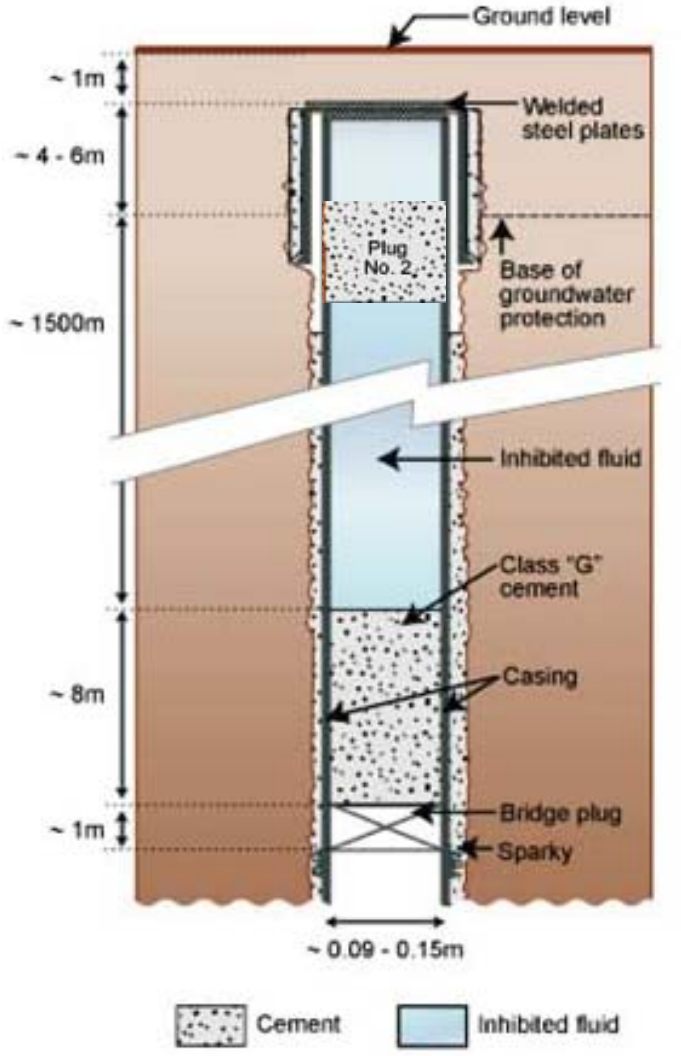


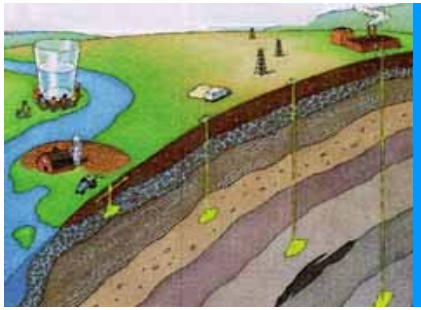
EPA's Proposed GS Rule:

Well-Plugging and Post-Injection Site Care

Basic requirements

- Appropriate well-plugging, monitoring and other actions following cessation of injection
  - Wells must be closed in a manner that protects USDWs from endangerment
  - Owner/operator must demonstrate and maintain financial assurance to close and abandon the injection operation
- Liability stays with owner/operator



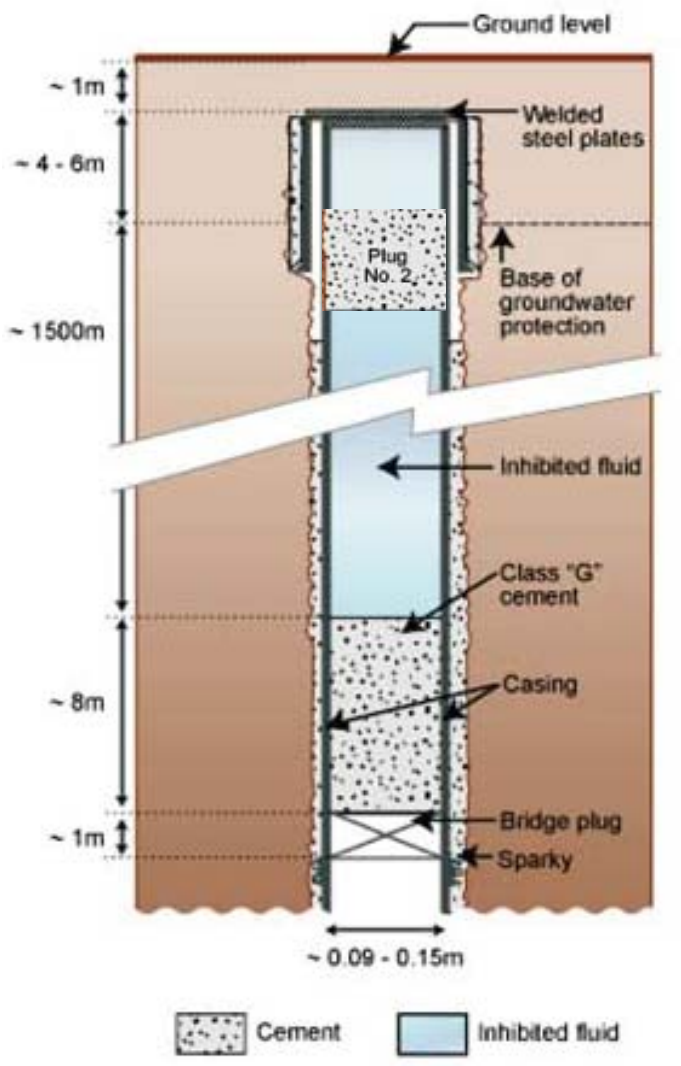


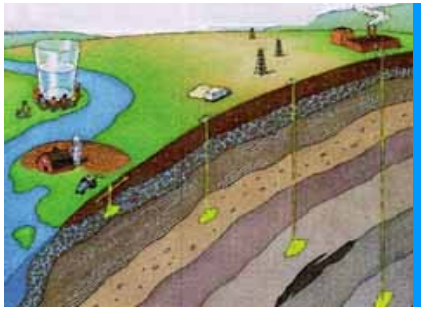
EPA's Proposed GS Rule:

Well-Plugging and Post-Injection Site Care

Proposed Approach

- Well-plugging materials must be compatible with CO_2 stream
- Post-injection site care is set at 50 years; however, it may be modified with a demonstration that the plume has stabilized and the pressure has dissipated sufficiently
- The owner or operator must demonstrate financial assurance through the end of post-injection site care





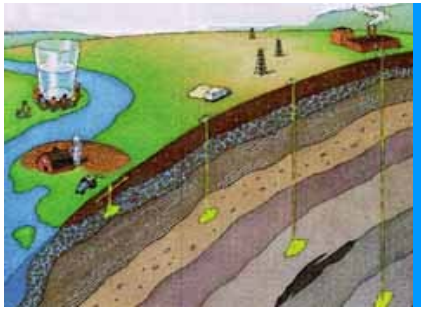
EPA's Proposed GS Rule: *Financial Responsibility*

Basic Requirements

- Show financial responsibility for well plugging and corrective action and for nominal site closure care

Proposed Approach

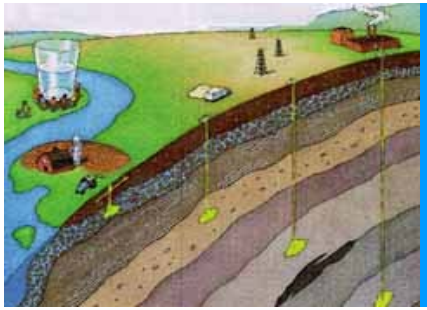
- Demonstrate and maintain financial responsibility for plugging and corrective action, injection well plugging, substantive post-injection site care, site closure, and emergency and remedial response



EPA's Proposed GS Rule: *Public Participation*

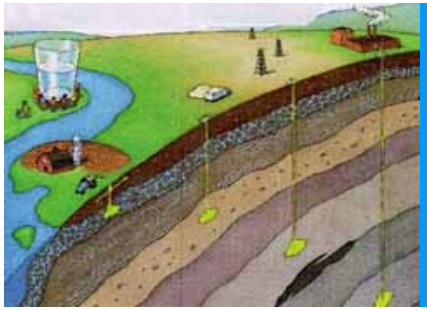
Proposed Approach

- 30-day comment period for permits following public notice
- Preparation of a responsiveness summary for the public record
- Seeking rule comment on:
  - Appropriate outreach techniques and technologies
  - Engaging the public early in permitting process before siting



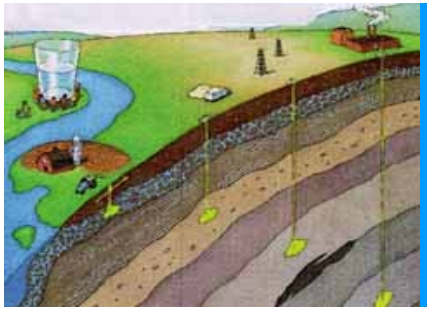
EPA's Proposed GS Rule: *Schedule*

Activity	Milestone
Technical Workshops, Data Collection & Analysis	Ongoing
Stakeholder Meetings	December 2007/February 2008
Interagency Review of Proposed Rule	Late May - Early June 2008
Administrator's Signature of Proposed Rule	July 15, 2008
Public Comment Period for Proposed Rule Includes 2 Public Hearings on 9/30 & 10/02	July 25 – **December 24**, 2008
Notice of Data Availability (*if appropriate*)	2009
Final UIC Rule for GS of CO_2	Late 2010 / Early 2011



Recent GS Public Hearings

- Format: Summary of Proposal, public verbal comments, followed by an EPA Q&A panel
- September 30th in Chicago: 60+ participants
- October 2nd in Denver: 60+ participants
- Generally favorable comments with some technical recommendations at both hearings
- Denver meeting in afternoon had several presenters opposed to GS, UIC, and continued reliance on fossil fuels for energy production
- Over 49 discrete groups have submitted comments



Thank you!

More information about the GS proposal:

- EPA Geologic Sequestration of Carbon Dioxide Website – http://www.epa.gov/safewater/uic/wells_sequestration.html
- Code of Federal Regulations: Underground Injection Control Regulations 40 CFR 144-148 – http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=d6ee71a544eca89c533c825135913f13&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv22_02.tpl
- Submit written comments for the proposed rule by **12/24** at: www.regulations.gov (docket ID is EPA-HQ-OW-2008-0390)